

## Unit 1: Embryonic Stem Cells, Natural and In Vitro Fertilization, Preimplantation Genetic Diagnosis

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### California State Standards

Biology/Life Sciences

2d. Students know new combinations of alleles may be generated in a zygote through the fusion of male and female gametes (fertilization).

3. A multicellular organism develops from a single zygote, and its phenotype depends on its genotype, which is established at fertilization.

### Goals

- Understand natural fertilization and *in vitro* fertilization
- Understand the stages of early human development and how they relate to stem cells

### Objectives

1. The student will demonstrate an understanding of the difference between natural fertilization and in vitro fertilization.
2. The student will be able to explain the differences between the morula and the blastocyst and understand how each relates to embryonic and fetal development.
3. The student will be able to explain the *in vitro* fertilization procedure in general terms from ovulation induction through embryo transfer.
4. The student will be able to describe the origin of pluripotent stem cells (inner cell mass) and their importance in medicine. Students will distinguish between totipotent and pluripotent stem cells.
5. The student will be able to describe how embryonic stem cell lines are developed.
6. The student will be able to explain Pre-implantation Genetic Diagnosis (PGD).
7. The student will be able to recognize areas of debate regarding the ethics of PGD and stem cell research.

## UNIT OUTLINE

### I. Invitation

#### A. Writing Activity: Assess pre-lesson knowledge

1. Describe natural fertilization.
2. What is infertility?
3. How did the "Octomom" become the mother of eight babies?
4. Draw what you think a five day-old human embryo looks like.
5. Have you ever heard about stem cells? If so, what have you heard about them?

#### B. Lecture: Stem Cells and Embryonic Development PowerPoint presentation

#### C. Discuss Octomom and the movie My Sisters Keeper

Use the following as stimuli for discussion.

See Bibliography for web addresses to clips (or click links below) and additional resources.

View clips about multiple births from *in vitro* fertilization:

1. Octomom complaint
2. Beth Goodman's quadruplets

View clips about My Sister's Keeper in this order:

1. My Sister's Keeper (2009) trailer
2. Interview with Jodi Picoult

## II. Exploration

### A. Natural Fertilization

1. Lecture on Natural Fertilization with graphic organizer "Human Fertilization and Development"  
 Appendix A: Natural Fertilization PowerPoint presentation  
 Appendix A: Natural Fertilization student worksheet  
 Appendix A: Natural Fertilization teacher version  
 Appendix A: Additional graphics, interactive animations, and lessons on embryonic and fetal development
2. Animation of Human Development and Stem Cells (Howard Hughes Medical Institute, BioInteractive)
3. Choose one or more of these lab activities:
  - a. Virtual sea urchin fertilization and development lab and other interactive resources
  - b. Sea urchin slides (Carolina catalogue #NP309702 Sea Urchin Development through blastula stage) and Appendix B: Sea Urchin Development Microscope Lab
4. Play-Doh modeling activity with graphic organizer "Draw Embryonic Development"  
 Appendix C: Play-Doh Modeling Activity  
 Emphasize stages/sites at which totipotent and pluripotent stem cells occur

### B. "*In Vitro* Fertilization" graphic organizer

- Appendix D: student worksheet  
 Appendix D: teacher version
2. View IVF clips in this order:
    1. IVF and ICSI
    2. 3D animation of ICSI
    3. Intra-Cytoplasmic Sperm Injection
  3. Assessment: Written comparison of natural and *in vitro* fertilization and description of the location of embryonic (pluripotent) stem cells and when you would expect to find them.

### C. PGD and Stem Cells

1. Discuss characteristics of totipotent and pluripotent stem cells and the formation of stem cell lines. Discuss ability of stem cells to differentiate and how this is useful medically. Use Teacher Background Information and this animation (HHMI BioInteractive) to develop discussion materials. Students should journal or write three questions they have as discussion progresses. Students then view the animation and answer their questions from the animation or further discussion.

Thought questions:

- How could scientists develop tissue for a patient?  
 What are problems with transplanting foreign tissue into a patient?  
 How might scientists get around this?

2. Jigsaw of articles activity or homework assignment: read abstracts and summaries of scientific journal articles. During class students get in "expert groups" to talk about questions, then break into "teaching groups" to share information from the articles listed.

Download Appendix E: Jigsaw General Instructions

Download summaries of research papers:

- Group 1 reads Thompson: Embryonic Stem Cell Lines derived from Human Blastocysts  
 Group 2 reads Damewood: Ethical Implications of a New Application of Preimplantation Diagnosis  
 Group 3 reads Vastag: Merits of Embryo Screening Debated  
 Group 4 reads Lanza: Human Embryonic Stem Cell Lines Derived from Single Blastomeres

Group 5 reads Hoffman: Cryopreserved embryos in the United States and their Availability for Research

Group 6 reads American Society for Reproductive Medicine: Preimplantation Genetic Testing: a Practice Committee Opinion

### III. Application

**A. Discuss ethics of PGD after the above jigsaw activity in the context of a standalone lecture or a policy forum. Students should each write two potential ethics problems after hearing jigsaw presentations. In an A, B interview, each student should present the two ethics questions to a partner. Each partner describes the ethics questions of his/her partner with larger group. The teacher writes students' points of view on the board.**

**B. Finish with a ranking exercise. Review the following policy options for regulating PGD (from Vastag article) then ask students to rank these policy options using the "Pre-implantation Genetic Diagnosis (PGD) Policy Options In Vitro Fertilization and Embryonic Development Application" graphic organizer.**

Download Appendix F: Policy Options Ranking Sheet

### IV. Assessment

Have students answer the following questions on the "*In Vitro* Fertilization and Embryonic Development Assessment"

Appendix G: Unit Assessment

1. Compare and contrast natural fertilization, IVF, and IVF with intracytoplasmic sperm injection.
2. How do the morula and the blastocyst relate to embryonic and fetal development?
3. How did Octomom have eight babies in one birth?
4. If Octomom and her doctors had followed the guidelines for the maximum number of embryos to be implanted, what could have happened to the remaining (unimplanted) embryos given Octomom's consent?
5. What are pluripotent stem cells and why are they important in medicine?
6. Compare how scientists would derive a totipotent stem cell line from a morula versus a pluripotent stem cell line from a blastocyst.
7. What is PGD and how might it help a family choosing *in vitro* fertilization?
8. How do stem cells relate to PGD?
9. What are some drawbacks of PGD?

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